

Rural Communities Workshop Technical Report

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I. Overview

The United States Department of Agriculture (USDA), with help from the University Corporation for Atmospheric Research (UCAR), hosted a meeting on rural communities and climate change as part of the National Climate Assessment (NCA) process on February 13-14, 2012 in Charleston, SC. The meeting had a total of 56 participants who came from federal, state, and local government, non-governmental organizations, and academia, and spanned a wide range of disciplines, from rural sociology, to agriculture, to rural development, to tourism and extension. Participants came from every corner of the nation, including representatives from such geographically disparate states as Alaska, Maine, Georgia, and Arizona. The purpose of the workshop was to foster dialog between these diverse participants to discuss rural communities and climate change, to provide them with information about the impacts of climate change on and adaptation actions in rural communities, and to develop recommendations for material to be included in the 2013 NCA report.

A major goal of the meeting was to generate this technical workshop report that will be submitted to the National Climate Assessment as part of the 2013 Assessment process. This report will serve as the compilation of oral discussions and presentations held at the workshop; it is not meant to serve as a scientific document, but is rather a collection of data, thoughts, and opinions shared during the workshop. This report will be used as input to the authors charged with the writing of the chapter of the Assessment dedicated to Rural Communities. At the meeting, workshop attendees were asked to share their expert opinions on how to anticipate and characterize changes in rural America due to climate change, how to provide both context and detail of the challenges to rural wellbeing associated with climate change, and how to set the stage for wise action that preserves rural community culture and resources.

The planning team for this meeting consisted of Jenna Jadin, climate change advisor in the Office of the Chief Scientist at USDA, Bill Hohenstein, Director of the Climate Change Program Office at USDA, and David Hales, former President of College of the Atlantic. The conference coordinator was Melanie Russ of UCAR, conference support was provided by Jill Reisdorf, and Rachel Hauser and Paula Robinson of the National Center for Atmospheric Research (NCAR) helped prepare this report.

The workshop covered two days, with presentations on the first day designed to provide background information on climate change and rural communities prior to the convening of breakout groups on the corresponding subjects. Plenaries were presented on the topics of rural communities, regional climate impacts, and the effects of climate change on rural communities. Pre-breakout plenaries covered the topics of human health and well-being, governance and finance, transportation and infrastructure, resource-based economic issues, and amenity-based economic issues. Breakout groups on these topics followed the background plenaries. The second day of the workshop focused on hands-on tools and knowledge for rural communities. Plenaries covering case studies of rural communities' adaptation practices were followed by presentations on outreach and extension with rural communities. Altogether, this second day provided participants with practical knowledge of how rural communities were learning to adapt to climate change and successful examples of how boundary officials and organizations were working with these communities. The second day ended with a facilitated discussion about knowledge gaps and future research, as well as a summary discussion led by the lead authors, which covered impressions from the workshop and a summary of important ideas. The full agenda for the workshop is

located in Appendix A, a list of breakout group questions is in Appendix B, and results from the breakout groups and facilitated discussions are presented below.

II. Plenary Summary

The morning of the first day was occupied by plenary sessions providing a background on rural communities, climate change, and their interaction. These talks were designed to provide a backdrop for everything else that was to be discussed during the workshop, and were necessarily broad and far-reaching. The first speaker discussed the characteristics of rural communities, provided statistics on rural communities throughout the United States, and sought to help the audience come up with a definition of what it means to be a rural community. The second presentation focused on regional climate change issues and provided projections from different models of climate change and projected impacts across the United States. The final presentation discussed a 2011 academic paper that summarized the limited research that has been done at the nexus of climate change and rural communities in the United States. The broad topical areas that this presentation highlighted included human health, transportation, indigenous communities, vulnerability, agriculture, tourism, forestry, fisheries, energy, water resources, and policy considerations.

The first plenary on rural communities had several conclusions and recommendations. Among these: that is difficult to define rural versus urban because the available statistics are usually aggregated to county level. The Office of Management and Budget (OMB) classifies counties as metropolitan or nonmetropolitan, with central metropolitan counties either having urbanized areas of 50,000 or more residents or having 25 percent of its workforce commuting to the central counties. Parts of these more peripheral counties are often quite rural in nature. The country has been consistently losing rural (nonmetropolitan) areas, both in terms of land area and population; currently nearly 80% of the land is rural, but rural populations constitute only 17% of the total U.S. population.

Table 1: Factors Influencing Rural Communities Adaptive Capabilities

Factors that Increase Vulnerability to Climate Change	Factors that Enhance Resilience to Climate Change
<ul style="list-style-type: none">• Geographic isolation• Limited redundancy in human resources• Limited redundancies in current infrastructure (roads, bridges, water systems)• Lower education levels• Poverty• Resource dependency• Difficulty raising capital for infrastructure investments	<ul style="list-style-type: none">• Independence• Land availability – flexibility in siting infrastructure• Lower land costs• Community identity• Improved access to information (broad-band)• Adoption of new technology (e.g. mid-west agriculture)

Rural communities tend to be vulnerable in many ways: many suffer from population loss particularly of young adults and their remaining populations tend to have less education than typical of urban areas, making them susceptible to low income. Rural communities also have a number of characteristics that

make them resilient to climate change, including independence and lower land costs (Table 1). With older populations and often relatively high poverty rates, rural populations tend to be more dependent upon government transfer payments than urban populations. But not all rural counties are the same: some with natural amenities have considerable population growth, and some, particularly in agricultural areas of the Midwest, are relatively prosperous despite population loss.

The plenary on climate impacts covered projections for climate change in the United States in the coming decades under several different model scenarios. Under all models, the United States experiences significant warming that will cause measurable impacts. Data from the last 20 years show a large number of record high-temperature years, and a general trend exists for increasing temperature over time. On average, precipitation also appears to be increasing over time, however, dry areas, most notably in the Southwest, are also getting drier. It was also notable that the largest temperature increases in summer and winter are occurring in the northern and high latitudes, where spring and fall are not expected to change so much; the greatest increase in frost-free season length will be along the West Coast, where growing season may increase up to 40 days.

The final plenary of the morning discussed how climate change will have some unique impacts on rural communities; these areas are often more vulnerable to climate change than urban or suburban counterparts. Some important points to consider include the fact that rural communities tend to be less affluent, have lower access to government services and health care, and are resource dependent. As a result of this they have lower adaptive capacity, which depends strongly on community wealth, equity, technology, developed infrastructure, and stable institutions. Additionally, forested counties are more adaptable than non-forested counties. According to a USDA report on forest-dependent communities there are a total of 837 low adaptability counties, which have total populations of 8.3 million Americans. These communities exist mostly in Midwest agricultural areas; only 12% of these counties are forest dependent. Finally, the impacts of energy costs could be huge in rural areas. Residents of the Southeast spend a lot more of their income on energy costs on summer-time air conditioning than is the case for populations in other parts of the country. These costs will only going to go up as it average temperatures increase. In turn, this will have huge health effects on poor rural communities.

Five experts next gave pre-breakout presentations on the breakout topics. The first of these covered rural health issues in relation to climate change. It was foremost noted that the first thing to remember is that little research about climate change and rural health exists, and much more is needed, especially given the large impacts that climate change may have on human health. In terms of how rural communities are structured, there is a very bimodal age distribution in rural communities, with many very young and very old residents. Both groups are plagued by a lack of access to health care, which declines with lower population density and increased geographic isolation.

Changing climate conditions that may affect the health of rural populations, include more heat waves, more cold extremes, more allergens, and more pollutants. Rural community members in some cases may be better adapted than urban residents to dealing with extremes, but it is expected that there will be an increase in water, food, and vector-borne diseases that could have a large impact on rural communities. Notably, when extreme events occur, immediate responses are often necessary, however, rural communities struggle to provide adequate emergency and medical services. This could be particularly problematic during natural and technological disasters and could have short- and long-term impacts upon

the health of rural communities. Finally, it is important to remember that in rural communities mistrust of government and outsiders exists, as well as a mistrust of medical professionals. A community-based peer support may help spread better health care practices.

Mental health could be indirectly affected if climate changes, and more widespread depression may result. Rural residents face a number of issues when they go for treatment for mental health services, including longer distances to travel to health-care delivery sites, greater disparities in health insurance coverage, and social perceptions of mental health issues. Research has also shown that rural residents are more likely to engage in risky behaviors, as well as suffer from work-related injuries that may have either mental or physical health effects.

The second presentation covered issues facing rural communities regarding transportation. The example provided came from the Maryland Department of Transportation (MDOT), where in terms of climate-change mitigation strategies, transportation officials are now about moving people, rather than moving cars. Toward this end, officials have looked to natural or human-made adjustments of actions to accommodate or reduce the adverse consequences of climate change. Not strictly limiting their goals to mitigation, MDOT also believes that better mobility means better air quality, which will benefit from efforts to keep cars moving, better managing lane strategies, shift transport modes, and restructuring transport carrying capacity. To address greenhouse gas emissions reduction, MDOT is increasing use of alternative fuels in fleet vehicles, using vehicles with higher efficiency, some of which have alternative fuel distribution systems, and banning vehicle idling.

The presentation concluded that state transportation plans need to consider adaptation to climate change as part of their goals. Highway systems and engineering must adapt assets for increased temperature, increased precipitation in spring months, a variety of forms of precipitation, increased storm intensity, storm surge, and sea level rise. The expected outcomes of climate changes on infrastructure include pavement rutting and buckling, more frequent and costly evacuation, scouring of bridge foundations and failure of bridge decks, increased power loss and traffic disruptions, and a washing out of coastal infrastructure.

Next came a presentation on governance and finance and rural communities, and the expected impacts under a climate change scenario. Key points included considerations of how local governments need to evaluate emissions and sinks, and identify critical vulnerabilities as part of their climate change and adaptation plans. At the local level, small towns typically don't have sustainability programs and don't have plans that consider climate change. Greater collaboration and assistance from federal and state governments, universities, and other non-governmental groups is needed to make local communities more resilient. A robust strategy should consider adaptation and mitigation needs, but ultimately the strategy must be scaled to abilities, needs and resources. Additionally, a focus should be placed on avoiding hazards before they happen: for example people should be discouraged from building on wetlands or too near the coast. Federal, state and local government needs to make citizens aware of the hazards and provide resources, such as emergency evacuation route maps, to protect residents and defray risks.

In terms of tools, revolving loans can be valuable; environmental finance groups located around the country can work with mayors and local councils to help them understand what sort of financing is available and how to put together loan packages that will work. Also, each local community should

carefully examine if it wants to do mitigation at the local level. In some cases where major emissions sources or sinks exist, it may be appropriate to incorporate mitigation considerations as part of local governance. In other areas, time and money might be better spent on making the community more resilient. Each community should go through a process to evaluate risks in as scientifically credible manner as possible, and after evaluating the risks, policy makers will have the tools to make appropriate decisions. Finally, governments need to be smart and aggressive about finding ways to bring in money to begin generating climate change responses going in advance of need. One way of financing energy efficiency and renewable energy projects is to focus on their “job growing” potential.

The fourth presentation of the day was meant to set up a breakout discussion about resource-based economies. Resource-based economies were defined as aspects of the communities that depend upon extractive use of natural resources, such as farming, fishing, and forestry. The presentation focused on agriculture and began by noting that growing seasons are likely to be longer, and CO₂ concentrations are likely to increase. In combination, over the short term, these effects will increase the yields of some crops, particularly in the South, while possibly decreasing yields of other crops, such as corn, wheat, and sorghum. However, a nonlinear relationship exists between yields and temperature; yields increase until a certain upper temperature threshold, and then they begin decreasing. It was also noted that climate change is expected to increase the cost of agricultural production, largely because of the extra costs required to control weeds and agricultural pests, in part due to the fact that the main herbicide currently used in the United States, glyphosate, loses its efficacy at high CO₂ levels, and alternatives to this chemical will have to be found.

Increases in spring precipitation will delay planting and crop establishment in the Midwest and Northeast, and lower temperatures throughout the winter can lead to premature plant development and blooming. Higher livestock production costs are also expected, due to increased requirements for energy to maintain healthy livestock. Some additional negative impacts will be experienced with California’s specialty crops, while the Northwest and Northeast may be too warm for growing some fruits, such as the cranberry. However, climate change could also be good for farmers: overall there is expected to be a 4% increase in agricultural profits from climate change, because as yields go down, the prices can be expected to go up. Finally, it noted that 75% of calories that humans consume come from four commodities: corn, soy, wheat, and rice. The United States provides 23% of the world’s calories in these commodities. In order to keep the U.S. farmers in the business of producing all of these calories, the speaker suggested that government programs should increase the probability of farm survival through subsidies.

Finally, the last speaker of the day addressed amenity-based economies. These were defined as economic and other activities that relied upon enjoyment and use of natural resources and include things such as tourism, hunting, and recreation. With this presentation, the audience learned that the United States earns more from international tourism than any other country in the world, generating a \$1.3 billion industry. With regard to climate change, tourists might anticipate two different types of climate impacts: direct impacts, and indirect impacts. Direct impacts are changes that directly affect the visit experience, such as snowfall volume, sea level rise, severe storms, etc. Indirect impacts affect the natural environment and include things such as composition of flora and fauna, increases in diseases and pests, and decreased water quality, all of which may be important to tourists pursuing activities such as wildlife viewing and

hunting. By the 2080s, climate model projections show that a very large portion of the country may have unfavorable conditions for outdoor enthusiasts.

The presentation noted that tourists and life-long residents comprise very different types of user groups. Life-long residents see the landscape as the provider for their living and work with changes; newcomers and tourists see the environment as a lifestyle decision and would like to see that the environment remains unchanged. Also, 79% of adults say they are environmentally conscious, but when it comes to making environmentally conscious tourism decisions, they often do not follow up on this claim. Finally, tourism enterprises in rural areas are predominantly small scale, family owned and operated, and have limited training in marketing, therefore cannot always adjust to seasonal changes or changes in activities as much as would be ideal. As a result, they tend to have short term planning horizons and fail to see climate change as important factor to take into consideration because its effects will occur too far in the future.

III. Breakout Summary

The remainder of the first day of the workshop was spent in breakout sessions. During these sessions, participants were self-assigned into groups of approximately 10 people. Each group was assigned a moderator and rapporteur who were responsible for guiding and capturing the group conversation. Each group was given a set of six questions to answer (Appendix B), but in many cases, the groups did not have time to address all six questions. After a period of time, the groups rotated into a second session in a different group, such that each participant took part in a total of two different breakout sessions. The following is a summary of the information that was provided by the participants during these small group discussions.

Health and Well-being

Participants in both sessions noted that health and well-being are not the same: health is a subset of well-being, and in this workshop focus was on about community and individual health. It is, however, important to remember that it is challenging to apply the concept of health to a community. Well-being is a contributor to diagnosable health situations, i.e., whether or not someone has a job, where their children live, or if they have social support. Each of these factors contributes to health impacts. Well-being is often invisible until one has a health issue. Well-being is a process, whereas health is a point in time. Participants noted that health is not simply the absence of disease, it also describes a resistance to disease, preparative actions to avoid disease, and the ability to maintain a positive state regardless of what is happening around you. The Centers for Disease Control may have a definition of health that will be incorporated into the National Climate Assessment.

Several participants noted that in terms of discussion about U.S. food security, surveys often include questions about food-related anxiety, not just about hunger or disease. In considering the effects on rural communities, climate change considerations need to include looking at more than just the direct effects of climate change on health, because the levels of anxiety it will engender must also be investigated. Some very relevant questions exist about anxiety levels, isolation, and nutrition that may be useful in identifying what is different about health in rural areas. It will also be necessary to separate out health effects among different regions of the country, as these are likely to vary widely from region to region. It is also necessary to remember that hydration is a major health issue for many groups. An awareness of best practices for outdoor workers is important, as is an understanding of the variation needed for timing of water breaks and how this affects health. Related to this, when talking about health, it will be important to consider the diverse groups of people involved and how climate-change affects differ across populations. For example, heat waves may affect migrant workers much differently than they affect other rural residents. Rural children also need special consideration. In some parts of the country, rural children spend more time outside than their urban counterparts; this could affect their health. Spending time outdoors has associated safety and security issues that may differ between urban and rural areas and result in additional differences in health between these communities.

Isolation can lead to health issues, which is compounded by lack of availability of transportation and related transportation infrastructure. Isolation could also block awareness of conditions critical for good

health, including sanitation and exposure to the natural elements. Isolation may be an important factor in identifying the relative prospects for good health, but it may also be a red herring. Researchers also need to look at overconnectedness, as well as the reliance upon a single chain for supplies, healthcare, and markets that occur in rural communities. Participants noted that evidence exists that people in rural areas are less risk averse when it comes to personal behavior; this may occur because these individuals are often more exposed to risk. Also, people who choose to live in rural areas consider themselves more independent by nature, which also may make them more prone to taking risks. There may also be different levels of belief about climate change in rural versus urban areas. A large hurricane response survey was just done for South Carolina, the results of which show that people do not perceive they are at risk; for instance, 70% of respondents who said they were not in a storm surge zone, actually did live in such a zone.

When considering health of rural communities, pollutants and toxins must also be considered. The increased use of pesticides, fertilizers, and herbicides in a changing climate may be a factor in rural health. Little research exists on direct climate impacts on health, such as on asthma and respiratory problems, but some research has been done on the more complicated indirect effects, such as mental health and the psycho-social factors that affect decision-making. Overall, little is known about what is happening in rural areas, so decision makers rely on inference and speculation that such effects must be different from urban areas. A community of scholars think they know what rural is, and while there is probably a lot of agreement on the idea of what rural means, a lot of misconceptions likely also exist.

The session concluded with participants pointing out that urban communities take for granted inexpensive food, energy, and water; more uncertainty about these topics exists in rural communities. Distinctions drawn between urban and rural may ultimately have to reflect a redistribution of resources, for example, urban areas demand clean water and rural areas can provide it. New York does this when it pays the Catskills to retain wilderness areas for catchment. Finally, one participant brought up the concept of bioindicators and noted that change in traditional diets might be used as a bioindicator of climate change and methods of adapting to changing environments and availability of, for example, different foods.

Amenity-driven economic factors: tourism and recreation

Participants in both sessions started by investigating what types of factors should be considered in the when talking about amenity-driven economic factors. Ultimately, they decided to focus on culinary tourism, agricultural tourism, cultural tourism, natural tourism, migration, second home development, hunting, fishing, winter sports, water sports, driving, sightseeing, hiking, camping, and wildlife viewing. The amenities under consideration included coasts, beaches, marine areas, water, mountains, public lands, parks, wildlife, plants, weather, and climate itself. The expected changes in these sectors as a result of climate change include seasonality, which will define what activities are feasible at what time, and availability of resources, given that storms and extreme events may preclude activities at times when they have historically been accessible. Ocean acidification will be an issue that will challenge some coastal economies, such as those dependent upon fishing, marine tourism, and water sports. There will be a chance of increase in catastrophic wildfires, storms, droughts, heat waves, and as a result there will be

some landscape conversion. In addition, over a longer time frame, treelines and species may move or cease to exist in areas where they historically existed.

Participants were asked about what some of the challenges will be to all of these economic activities as a result of climate change and it was noted that it may be challenging to find seasonal staff. Some resorts depend upon students to staff their vacation season, and when that extends into spring and fall, students may not be available. The converse problem of not enough jobs may also be an issue in some areas, particularly areas where people are dependent upon winter recreation for employment. Climate changes may affect some indigenous tribes who may be driven out of areas that become more tourist oriented. Other tribes may face the challenge of watching their amenities disappear even as they become increasingly tourism-dependent. Coastal areas will become submerged and there will be conflict over resource use, such as beach access, and access to fresh water. Coastal tourism will be especially affected by climate change: increasing storms will have insurance implications for homeowners and insurance agencies. Insurance rates will likely go up, and in some areas it will be more difficult to get insurance. Swiss Re, a leading global reinsurance company, may be looked to as a source of information, as they have done quite a bit of work on climate change and related risk. In particular, insurance payments by and to ski industries (weather derivatives) will increase. Finally, it was noted that the employment change in rural areas could go up or down, depending upon the area; mostly it will just be different. Employment may end up being focused on providing urban amenities to changing populations who have moved there.

Migration to rural areas was also discussed. Migration erodes the amenities that people are moving out of the cities to be closer to. Urban-to-rural migration may increase as climate changes and temperatures in urban areas rise, because people will be looking to move out to the country where it is cooler. This may result in poorer people in rural communities getting pushed out of places in which their families have existed for generations. Those who move to rural areas for their amenities are typically older people with access to resources. This shifting demography will put additional pressures on age-related infrastructure, such as health care systems in rural areas. It will be important to incentivize service providers, such as doctors, to also move to these areas so as to respond to changing community needs. These migrants will also bring in different social classes with different access to power and money. Finally, it was noted that people often derive enjoyment from just knowing that amenities exist nearby. Migration occurs because the appeal of an amenity creates activities around the values of the amenities.

Participants were also asked about actions the government might take with regard to amenity-based economies in rural communities. Many noted that there are implications for getting federal and state governments involved, and that local governments need to be empowered prior to involving higher-level government entities. Different levels of government can play important roles in providing incentives, such as permit trading, providing incentives for industries to relocate, and providing incentives for farmers to stay in farming. Governments need to recognize legacy resource issues and address them first; there are some resources that need to be protected whether climate is changing or not, such as resources protected by historical rights. The government also needs to get involved in education so as to help rural communities better prepare for the future and the possible effects of climate change. A way to educate communities is to provide down-scaled data from climate models that help decision makers come up with well-reasoned and community-relevant decisions. However, when dealing with rural communities, it is important to not take a “loading dock” approach, where all of the issues are piled on the community

without clear organization or allowances for division of labor. There is limited human resource capacity in rural areas, with one person often filling multiple civic roles. It is also important to remember that climate change adaptation must be a people-based process; governments should not just provide a website designed to help with adaptation and mitigation, but instead should provide a meaningful translation of information and planning assistance. Knowledgeable facilitators with relevant expertise need to be brought in to directly work with rural communities in areas where expertise is lacking. Often, rural communities often feel underrepresented in the planning process. Also, representatives from academia and governments need to visit rural communities and find out what community residents want and need – with an emphasis on listening rather than telling. Extension is good for this, as are NOAA’s Regional Integrated Sciences and Assessments (RISAs), state Bureaus of Forestry, and Resource Conservation Districts. Good use needs to be made of these resources.

Agriculture was briefly discussed. Communities should be encouraged to support local agriculture so that a viable green space exists year around, with farmers possibly being paid to keep their green space. Rural communities should work with agencies that maintain public lands, and incentives for preserving rural lands should be considered. Participants noted that it is important to keep in mind that reducing agriculture could also increase tourism; this happened in the South, where people now spend more time vacationing because a greater number of forests and wildlands exist now than did 50 years ago. People may want to visit real prairies more than they want to visit rangelands, and compensation for ranchers should be considered in order to make this happen. Conversely, however, agricultural tourism is a growing sector.

Rural communities may need to become more flexible socially and culturally, however, many communities may feel that government regulations prevent them from gaining the required level of flexibility. Also, social networks in rural communities include extension agents, resource conservation managers, rural water associations, churches, local sporting events, and may be tapped to facilitate climate adaptation strategies. The old networks that supported rural communities are disappearing, and we need to think about whether or not there is any way various levels of government might better support these existing networks.

Rural communities are naturally resilient. They have an ability to repeatedly reinvent themselves, as shown by boom and bust cycles throughout the years. An example of this is the Hudson Valley, which used to be an energy community and is now an artist-based community. Some communities may be capable of reclaiming assets that historically existed, however communities are likely to experience trouble when they focus on just one particular sector. Those who work with rural communities need to focus on marketing a way of life and a shared heritage, in which change is a normal part of the existence. Also, many communities won’t have the ability to diversify, but networks with neighboring areas can be created that allow communities to create diversity through linkages with neighboring areas.

There was overwhelming agreement among participants that it is important to realize that the NCA chapter may try to analyze rural communities on an overly aggregated scale. Rural communities are very different in different parts of the country, depending upon physical factors, community resources, economic activities, and social attitudes. Additionally, as urban migrants move to rural areas, there is going to be conflict between value systems both within and between rural communities.

Adaptation to climate and other social, economic and political change by rural communities may be achieved by using old resources in new ways, or bringing in new resources to fill a niche that no longer exists. For example, some former timber communities now ship lumber in from Canada to make windows. In instances such as this, it seems likely that there will be a gradual transition in rural areas from resource-based to amenity-based economies as the nation moves further along this existing information economy. However, when communities transition in this way, it can mean creation and dependence on more low paying jobs.

Many pointed out that most communities are more focused on what will happen next year rather than in three decades or more. This is part of the rural value system, and any actions in rural communities will have to be done in the context of that value system. Also, it is important to remember that while people may respond to immediate needs, their risk perceptions decay with time.

Community history also needs to be considered when we make plans for how we are going to work with communities. Because of the negative history, black farmers are reluctant to work with USDA, although they are willing to work with Extension. Likewise, the ski industry is skeptical of climate change experts because they believe the climate change community thinks ski resorts are bad for the environment. Boundary organizations are useful in these cases because they are seen as a neutral translator between the government and rural communities. Trusted sources are going to be necessary sources of information for rural communities. Climate change is not currently a problem that rural communities want to deal with. Because of this, it is necessary to be very careful about framing when discussing climate change issues. It may be better to focus on community resilience to weather and environmental change, rather than “climate change.” When communicating, it will be important to link to existing value systems, and give communities a reason to respond today. Value systems might be different for every community, and only by listening will outsiders understand that system.

Finally, some concluding thoughts were that there needs to be a focus on high school graduation rates in order to prepare rural communities for coming changes. It was also noted that the majority of employment in rural communities is in the service sector. Communities might develop more transient and international populations, particularly in recreational areas that have extended seasons and rely upon students and international labor to fill job slots in this sector. Finally, one participant pointed out that many places are losing their attractiveness as climate changes, such as in the West, where pine beetles are currently destroying landscapes. As habitats change and species move, private groups or the government may want to consider buying new land to accommodate shifting species or to preserve existing landscapes.

Resource-based Employment and Economics

A wealth of natural capital resides in rural America. However, some workshop participants suggest that the nation’s natural capital and ecosystem services are often not appropriately valued in the current market economy. To some degree this might be because “rural America” conjures images of rolling fields of waving wheat, corn, or soybeans. But in terms of resource-based employment and economic considerations, agriculture does not exclusively define the economic base of rural American communities. Often overlooked, forestry, range land, and fisheries are among the other important components that make up America’s wealth of natural capital and resource-based employment options.

The economic, natural system, and resource mix differs across the United States, with each rural community having its own unique combination of resources and resource-based economics. These varying community characteristics, taken in combination with distinctive political, environmental, and economic geographies mean that communities often face one-of-a-kind challenges from changing climate.

Challenges may include water resource stresses, enhanced primary production in natural and human-made ecosystems, lengthened growing season, greater pest and weed resilience, and warmer average winters due to changes in temperature, precipitation patterns, and increased atmospheric carbon dioxide concentrations. The manifestations of these changes, how communities cope with such challenges, and resource-base resilience to change will differ. However, a common factor across rural communities is that economic and political vulnerabilities, which are tied to a community's ability to adapt, as well as the resilience of the resource base under consideration, may face increasing challenge in the future.

The inherent heterogeneity of communities, community problems, and ability to adapt to change, whether climatic, economic, or political, mean that one-size-fits-all solutions for rural challenges are difficult to find. Recognizing the reality of these broadly diverse community cultures, needs, and economic bases, the two breakout groups considering resource-based employment and economies saw flexibility in governance at all levels (from local to federal) as an essential component in helping communities address unique and changing situations related to climate and locality. Notably, both breakout groups had little representation from those working or living in rural communities focused on freshwater fisheries, aquaculture, or forest-based industry. In future discussions including voices from these communities will be important to assess the full spectrum of needs related to climate change, as well as the adaptation capacities of these communities.

Many climate projections focus on changes in average temperatures, precipitation, and carbon dioxide levels, however, agriculture in particular lives or dies on the extremes. Climate change can cause or exacerbate direct stress through high temperatures, reduced water availability, and altered frequency of extreme events and severe storms. Warmer springs and longer growing seasons can, assuming adequate moisture, increase agricultural and forest productivity. Climate change can also modify the frequency and severity of stresses. For example, increased minimum temperatures and warmer springs extend the range and lifetime of many pests that stress trees and crops. Higher temperatures and/or decreased precipitation increase drought stress on wild and crop plants, animals, and humans. Reduced water availability can lead to increased withdrawals from rivers, reservoirs, and groundwater, with consequent effects on water quality, and stream ecosystems.

Particularly affecting agricultural and wildland sectors, warmer average winter temperatures will increase pest and disease prevalence due to a reduction in cold periods (cold spells kill insect larvae, and longer growing seasons favor fast-growing weeds and invasive plants). In addition, increased incidence of drought will stress plants and increase wild fire risk, earlier spring snowmelt may increase likelihood of flooding and reduce availability of late-summer water resources, and tendency of fewer but more intense precipitation events will affect soil resources and erosion. In forests, highly stressed trees and other plants and animals may not be equipped to adjust to new or increased stressors, which will affect biodiversity. Some agricultural regions may benefit from increased carbon dioxide and, with help from irrigation and drainage technologies, may withstand some effects of drought and changes in precipitation and snow-melt patterns. However, this resiliency will likely be tested if carbon dioxide concentrations and temperatures continue to rise.

In freshwater and marine ecosystems, changes in temperature and precipitation will affect aquaculture. In freshwater systems, increases are likely to be seen in rates of primary productivity, organic matter decomposition and nutrient cycling due to higher temperatures and longer growing seasons. Additionally,

a reduction in habitat of cool-water species, as well as a reduction in water quality, and loss of organisms due to more intense flushing of streams and wetlands is likely. In coastal areas and marine fisheries, warming may increase eutrophication, particularly in areas with significant runoff from nearby agricultural fields, which will affect types and abundance of desired species. Many of the expected climate change effects will exacerbate current anthropogenic stresses, including increasing demands for water, increasing waste heat loadings, and land use changes that alter the quantity and quality of runoff to streams and reservoirs.

Significant conversation on diversification of rural resource-based economies occurred within both breakout groups. Education is seen as key to successful adaptation to current and future climate change impacts in rural communities. Education and related training will facilitate skill development that either helps community members shift to employment and economic alternatives that extend beyond traditional resource-based opportunities, or will allow better understanding about and/or new insights related to managing the environment and available resources in the face of change.

Many of the participants pointed to Extension Services as an organization that is seen in many communities as a trusted source of information. Extension agents not only provide useful information on climate and other issues, but also offer a source for training and topical learning. However, some participants raised concerns that a lack of funding may reduce the utility of this resource, which could be detrimental during a period when transfer of knowledge might help communities more readily navigate changing climate and the associated environmental and social impacts of change.

Some communities may experience an exodus of rural youth to cities, which provide more opportunity for education, employment, and improved economic future. However, many families choose to remain in or move to rural areas because they like the lifestyle and perceive the environment as a safe place to live and bring up their children. In addition, a population of rural residents that is sometimes forgotten are the new, oftentimes wealthier-than-average residents who seek second homes in quieter, resource-rich communities (e.g., near waterways, coasts, mountains), or those who have jobs that offer the flexibility to pick their base of operations. The effects of this incoming new population include changes in tax base, potential shift in community focus and perceived needs, and oftentimes increased disparity in income. Such shifts in population make-up may support more service-based economies, with an average increase in residents' disposable income precipitated by new populations. Balancing traditional resource-based economic and employment with new needs may offer a challenge that changing climate and its effects may exacerbate.

Whether in-migration of new populations is occurring in a given community or not, many heads of rural families already work in fields other than or in addition to the established resource-based jobs related to, for example, farming, fishing, or forestry. Reasons for this reality vary, with some individuals requiring a means of subsidizing incomes, while others may need a means of gaining more affordable health insurance, for example.

In terms of both employment and economic sustainability of rural communities, discussion of the lack of viable markets to promote and sell ecosystem services is oftentimes lacking – or taken for granted – in the United States. Clean water and air, and the natural aesthetics native to many rural communities are considered an intangible benefit that generates little monetary remuneration to rural residents. Participants pointed to a need for developing a federal policy to support investment in rural areas, as well as some way of facilitating local ownership and control over community assets. Pursuing such policies, which would include pricing that is high enough to support cost of living and production, has the potential to sustain rural communities economically, and would empower community leadership to maintain pristine ecosystems and ecosystem services. It might also incentivize development of sustainable or adaptive

strategies to manage available resources and services in the face of changing climate, the effects of which might otherwise threaten the community's natural resource base.

Governance, Finance and Related Resource Inputs

Many rural communities are already dealing with or planning for the effects of climate change, although, as one participant pointed out, oftentimes these issues are not labeled as being climate change effects. Examples include preparing for effects of sea level rise and the potential for flooding along the coasts, increased precipitation intensity and increased soil erosion in agricultural areas, and warmer, shorter winters that impact the ski economy in mountain towns. Governance – the structures and processes by which people in societies make decisions and share power– and financial commitments influence how these adaptation strategies are shaped.

While the original intent of the breakout group discussion was to focus on governance and finance, several participants pointed out that cost considerations extend beyond simple dollar-and-cents considerations. Therefore, the category was expanded to include non-financial inputs that affect a community's ability to manage impacts of climate change. Among these are limits to manpower, time, attention, expertise, technology/tools, and technological/tool know-how.

Not all communities have the resources to implement multifaceted climate adaptation strategies. Communities would benefit from help from outside experts in evaluating local risks in as scientifically credible a way as possible. Resulting risk outputs can then be fed to policy makers at both local and upper levels to consider as part of both community-scale and larger-picture risk management decisions. In achieving this end, it is important to note that communication of needs, options, and expertise needs to occur in a two-way dialog between community leaders and larger-scale authorities. Oftentimes, federal, state and non-local policy makers and experts talk down to community leaders and those living in rural areas. Rural leaders are experts in local problems, are steeped in the community culture, and have intimate knowledge of what community members consider important. Approaching policy and expert interactions with the notion of sharing and exchanging ideas rather than handing down non-local perceptions of problems and solutions will ultimately benefit all parties.

Among the benefits of risk assessment and dialog between community decision makers and outside experts may be a sharing of learning that reaches beyond a single community. As noted repeatedly, few if any rural communities are exactly the same, but some have similar climate-driven problems or economic or resource characteristics. By enabling cross-community conversations and sharing of solutions that work, leaders and policy makers at all levels may glean critical information that will allow rural (and other) communities to navigate impacts of changing climate. Also, by embedding climate change adaptations as being part of the suite of issues related community sustainability, the "climate change" stigma (climate change is often seen as a controversial topic), will be less likely to arise by putting challenges into a more universal context that bridge across disparate communities.

As was the case in looking at resource-based economies, participants felt strongly that successful governance had to allow for greater creativity and flexibility in identifying solutions and enforcing regulations that worked for individual communities. Often, federal, state and even local regulations do not fit situations faced by rural communities. For example, regulations designed to deal with waste-water management in large cities like Phoenix will not work in parts of rural Arizona. And regulations created for the arid Southwest will not translate well when trying to address the needs of northern Maine populations.

Among some of the considerations when it comes to making decisions related to community sustainability, legitimacy of decision makers is important; this includes trust of the community in the individuals responsible for making choices. Transparency – how, why, and who made the resulting choices – and a semblance of inclusiveness and fairness as decisions are made is also important and will facilitate community support for decisions. Also, integration across and between levels of government and community members, and adapting new knowledge into governance structures so as to ensure consideration and inclusion of the latest community requirements will allow healthy policy evolution that continues to anticipate and address community needs.

In both sessions, a large part of the discussion focused on communication. Discussion of climate change in many cases immediately puts community members and leaders on edge. Climate change is often seen as a contentious, elitist issue that will involve the community taking on expensive, potentially irrelevant regulatory requirements – requirements that are handed down by higher-order governmental organizations that are out of touch with the local community's needs and capabilities.

Participants offered a variety of suggestions to work around this issue that would achieve the desired climate change adaptation ends, such as avoiding discussion of climate change and focusing on the community-specific issues that climate change might have brought on or is exacerbating, for example, increased and stronger flooding events, or ways of managing an increasing number of heat waves. By embedding climate change in broader issues such as hazards in questions of community sustainability, and shifting focus to local and immediate problems and/or examples of where people can make a difference, local community members can tackle relevant problems that make a difference to their well being. Participants suggest that it is important to look at locally relevant extreme-event models and solutions, for example, to consider what extreme events are worrisome to a community, and how do they prepare for these events.

It would also be beneficial to change the framing of the discussion, suggested participants. Currently, timeframes discussed by policy makers at federal levels and scientists may be 50 to 100 years in the future. As is the case for most people, whether urban or rural dwelling, short-term thinking predominates. A better time frame for discussing climate issues within the community might be within range of 10 to 20 years – about the amount of time needed before the kids go off to college. Also, framing climate issues within a narrative that is relevant to the community facilitates conversation about potential problems and ways in which these might be dealt with.

Participants noted that Extension Services already do a good job of framing climate and issues of importance to rural community members in a comprehensible narrative, and their services will be beneficial in the continued assistance with these efforts. Extension is perceived as being part of and pursued in service to the community. Its agents are seen as having no agenda, and their expertise is broadly accepted. Extension agents can captivate large audiences relative to problems. Moreover, participants pointed out, agents can ask rural community members for suggestions about solutions to climate-related issues affecting the community, with ripe discussions often ensuing that engage the public in pragmatic solution finding.

Also important to these discussions, suggested the participants, is familiarity with other members of a discussion group and the group size. Often, stakeholders feel more comfortable speaking to a smaller group whom they know and who have similar needs. If taking this small-group-discussion approach, it will also be important to create bridges between the smaller groups and larger-scale government. Small groups might network together and then combine forces with other groups to form a larger group that works directly with those who are driving policy decisions. Alternatively, boundary organizations exist (Extension or groups like Oxfam are examples) that might provide a link between communities and

higher-level decision makers, as well as provide a link for rural communities and leaders to available funding opportunities and non-local expertise

Financial considerations can shape public behavior. Because of this reality, policy makers and authorities at community, state and other levels might benefit from considering what behaviors should – or could – be encouraged through financial vehicles or policies such as taxes or incentives. Identifying the desired behavior will provide some indication of what financial incentives or disincentives might work best to achieve these ends, whether this is to encourage greater energy efficiency, building outside of a potential flood plain, ensuring well-being of more needy segments of the population, etc. Equally important is weighing the cost of inaction to effects of climate change versus costs of action; would a community do better to shore up a beach or wait for federal funding in the event of a future disaster? If the beach is a major source of tourism revenue for the community, adding a “use tax” in admission fees for beachside visitors might be warranted. Alternatively, if the beach is little used and damage from storm surges is relatively minimal, insurance or looking to the Federal Emergency Management Agency for help might be the preferred community approach. Some part of these choices will likely be influenced by the regional community make-up, varying interests, and community history.

A significant non-financial input that should be considered in rural community capabilities in the face of changing climate is the level of technical capability. From a technological perspective, climate change can be data intensive. Some community leaders may not know that data or information exist to address their needs. Alternatively, they may not be able to understand what the available information indicates, or lack the expertise needed to work with the technology and tools designed to assist with interpreting available data. Moreover, such tools and access to expertise may be beyond a community’s budget. Assistance with finding the resources to hire a consultant or new employee who has the skills and background needed to interpret the available information in a useful manner, or finding funding to cover the cost of building infrastructure needed as part of the adaptation strategy counseled by hired experts would be useful. Community governing organizations are often volunteer-based, and whether rural or urban, expert knowledge about how to calculate risk is often lacking.

In some case, efficiency and equity come into direct conflict. For example, spikes in flooding may cause sewers to experience more frequent overflow. The wastewater infrastructure will need fixing, but doing so can often cost staggering amounts of money, and poorer communities are more likely to face funding issues related to dealing with changing infrastructure requirements. It is these communities that most lack in power, influence, and money that will have the greatest difficulty in raising bonds or coming up with other alternatives to finance such projects. Breakout group participants suggested that offering “lifeline” rates that would allow state or federal funding agencies to assess what the community can pay and subsidize the remaining costs to ensure that communities are not cut off from necessary services. However, it is also worth noting said the breakout group participants, sometimes political will becomes an issue. People see a problem, but don’t want to pay to have it fixed, particularly if the problem is framed as climate-change related. By reframing the narrative and moving away from confusing or inflammatory language, some of the concerns and policy sticking points might be avoided.

Another issue of equity faced by rural communities might come down to the level of available knowledge. Using real estate as an example, participants suggested that land is a limited commodity that has an associated value. But this value, under changing climate, could become grow or diminish. Some people may have a better sense of how the value will change and can take advantage of this knowledge, whereas others – often poorer individuals – cannot. This knowledge or lack of knowledge can affect communities. Such issues of equity need to be considered by decision makers at all levels, especially in low income rural communities where a greater awareness of potential issues or connections might help community leaders and members take advantage of a changing environment.

Energy, Infrastructure, and Transportation

Under changing climate conditions, rural communities will face challenges related to energy, infrastructure, and transportation. A lack of redundancy in energy, infrastructure, and transportation capabilities and services may prove problematic for rural communities under changing climate. For instance a lack of alternate transportation routes or over-taxed infrastructure, such as power plants and water treatment facilities, could be adversely affected by an increase in temperature or extreme weather events, and lacking redundancy in capabilities, rural communities may suffer.

As is the case with the other aspects of climate change effects on rural communities, impacts will vary greatly depending on location. In coastal areas for instance, sea level rise and extreme weather events such as hurricanes will affect infrastructure such as bridges, levees, sea walls, roads, and sewer systems, with cascading effects impacting transportation, including traffic flow on highways, rails, airports, and other major conduits of people and commerce. Regional climate change will also affect energy demand and supplies. While costs for summer-time cooling will increase across the nation, rural communities, particularly those in southern regions where most of the persistently poor communities exist, may be especially vulnerable to higher energy costs. From a positive perspective, heating costs may decrease as global average temperatures decrease. In addition, if the United States moves away from traditional energy sources – natural gas, coal, and oil – to offset greenhouse gas emissions, alternative power sources such as biomass, solar, and wind-generated energy may be used. If this is the case, rural regions may see economic benefits, with farmers paid to grow and harvest cellulosic-fuel feedstock and agricultural residue. Similarly, if the federal production tax credit is extended beyond 2012, wind and solar energy generation may become a source of jobs and power to rural communities.

Concern exists that many rural communities act reactively to climate policies, rather than proactively. To some degree this reactivity may be due to limited resources, which are not restricted just to financial resources, but include limitations in time and manpower, as well as critical skills and tools that could assist in decision making. This lack may contribute to smaller communities frequently having reduced or weak governing capacities. The size of governing organizations and the communities themselves are limiting factors in making decisions and exploring options related to local energy, infrastructure, and transportation needs.

With increasing pressure on existing energy sources, rural communities' access to traditional energy sources could be threatened by climate change. Increased demand for energy as well as lower or uncertain supplies in many areas could accentuate such threats. In addition, changing precipitation amounts and runoff may result in lower water availability for energy production in some regions. However, renewable sources of energy, such as biomass-based energy, may increase energy supply, create jobs, and reduce reliance on fossil fuels. The biomass-based energy markets could benefit rural landowners in terms of higher product prices as well as increased avenues for employment. As participants noted, danger of creating food security issues exists if using agricultural crops for biomass fuel production.

Energy demand is expected to increase in the future as a result of climate change, however new technologies or increased energy efficiencies in homes and buildings could also decrease the amount of needed energy in the future, thus decreasing energy costs. Storms also have costly impacts on energy systems. And in the event of increasing numbers of severe storms, rural communities may suffer from future hurricanes, thunderstorms, flooding, and related events that damage energy infrastructure or impede power generation.

In terms of “clean energy,” trade-offs exist. Economic benefits of ethanol and biomass production to farmers in rural communities are attractive, but food security issues may be a future worry. With regard to

renewable energy options such as solar and wind, some level of energy redundancy will be necessary to ensure power generation when the sun does not shine and the wind does not blow. Most likely, this back-up power will come from traditional fossil fuel sources such as coal plants or natural gas. Also, ownership and control over energy resources, whether energy is provided by a regional power company or by rural cooperatives, will influence energy-related decisions and policies related to adapting to the effects of climate change.

Public infrastructure consists of the assets controlled by local government that are necessary for rural populations and businesses to function, such as roadways, bridges, railway tracks, water management and solid waste facilities, etc. Much of this infrastructure may suffer from climate change related damage. The threats and possible adaptive strategy to minimize such damage will be an important consideration for rural communities and should be incorporated in both long- and short-term strategic planning. Costs of wastewater treatment, for example, will increase in areas where water levels are low, while maintaining roads in the event of increased storm-water runoff or increased flooding can increase maintenance costs.

Because of scale and costs associated with infrastructure, participants noted the need for leadership in responding to climate change. In this case, leadership from outside of the rural community may be embraced to a greater degree than in other cases, however, getting local input to understand the unique characteristics of the area is encouraged. A need was noted for new forms of cooperation, particularly between urban and rural communities. Demand and supply for critical resources, such as clean drinking water for instance, would greatly benefit from cross-community discussion to assess trade-offs between agricultural, human consumption, wastewater, and species and ecosystem requirements. Again, participants pointed out issues with rural community resources related to the capacity and strength of governing in rural areas, and the related ability to adequately represent rural needs in the face of urban communities that have a larger population of experts available, are better organized, and have greater resources related to governance, monetary and power.

Transportation capabilities make up a significant portion of any community's basic infrastructure. Climate change will have significant impacts on transportation infrastructure and service capabilities such as delivery of commodities to market. Among the possible impacts:

- Hot days could cause thermal expansion on bridge joints, and paved surfaces and pavement integrity could be compromised leading to traffic-related rutting, and liquid asphalt migration.
- Roads, rail lines, and airport runways in low lying areas will be inundated by the combined effects of sea level rise and storm surge.
- Increased flood events will intensify erosion of the road base and bridge supports, and will reduce under-bridge clearance. Pipelines could experience scouring and damage from flooding.
- Extreme rain events will increase flooding of roadways, rail lines, and runways and lead to road washout, damage to rail-bed support structures, and land/mud slides.
- Port facilities will experience higher tides and storm surges.
- Hurricanes may become more frequent and grow in intensity, leading to a greater probability of infrastructure failures.

To take one extreme example of the effects of the possible effects that climate will have on the frequency of extreme weather events and the resulting aftermath, the 2005 hurricane season imposed public and private costs of billions of dollars across the Gulf Coast, with the cost of rebuilding roads, bridges, and utilities a major part of this expense. Transportation infrastructure in Louisiana and elsewhere in the nation will have to be able to withstand the impacts of higher temperatures, extreme precipitation, and increased storm events. As just one example, storm damage to infrastructure will be expensive and will

require improvements to planning that incorporates potential impacts from larger storm surges, extreme rain events, and hotter temperatures.

It will be important to address not *what* to adapt to but *when* to adapt. Risks are assessed and activities prioritized based on anticipated impact and whether consequences will be in near or distant future, with priority focus and funding being on near-term impacts that have a low variability in occurrence. More work is needed to better understand the timing of adaptation responses – especially for responses that require investments in new capital infrastructure or potential dis-investments in existing infrastructure. Across U.S. rural communities, similar planning will likely be needed in future to assess how climate change might affect transportation.

IV. Adaptation in rural communities

The second day of the workshop primarily focused on on-the-ground efforts in local communities to adapt to climate change. Presentations on this day provided an overview of adaptation efforts in three different geographic areas, detailing both what the issues were that communities faced, as well as the efforts they had undertaken to adapt to already-present changes. Presentations also described outreach efforts with local communities, elucidating best practices and lessons learned in two different rural communities in the United States.

Case Studies

The first presentation described the efforts at adaptation undertaken by rural communities in the San Juan Mountains of Colorado under the San Juan Climate Initiative. This region is characterized by considerable biodiversity, a high percentage (69%) of public lands, and a “New West” economy driven by (in order of significance) tourism, second home development, oil and gas, and agriculture, as well as a large disparity between incomes, and many homes located at the wildland-urban interface.

Western Colorado is the second-fastest warming area the United States, and within it, higher elevations are warming faster than lower elevations. Snowmelt is now two weeks earlier in western Colorado during the period from 1974-2004, which affects water rights. Large wildfires have increased dramatically since the mid-1980’s, a sudden decline in aspen growth has occurred, and changes in species phenology are occurring, such as marmots that are emerging 38 days earlier than usual. In the future, this area is expected to become warmer and drier--especially in June, snowpack will melt earlier, and peak streamflow will shift to earlier in the spring.

Southwest Colorado can prepare to adapt to these changes in many ways, including by focusing on partnerships, monitoring change, developing education initiatives which summarize projected change, doing research reviews of climate science, producing usable downscaled climate models, and developing climate and energy action plans, as well as forest and water adaptation plans. The community has thus far been engaged in adaptation efforts in several ways: they have developed a “sustainability showcase” to highlight ways that people are adapting to the changing environment, they have used citizen science monitoring programs, they have worked on full scale experiments with researchers, and they have supported college and high school field based programs and internships.

The second “case study” presentation covered adaptation and climate change issues in the Outer Banks of North Carolina. In low-lying coastal areas, climate issues are more urgent and systematic than in other

areas, and rather than adapting in place, people may actually just have to change location. However, in the Outer Banks, the community is still in a state of denial about climate change: a group called NC-20, has spent thousands of dollars to conclude that there is no scientific basis for climate change. As a result, climate change and related impacts will not be included in building and permitting decisions. All of this despite the fact that coastal areas will generally become uninhabitable over the long term, and will be costly and risky to stay remain in in the interim. And not only are these areas becoming uninhabitable because of rising sea level, but water quality is going to become an increasingly important issue in these communities, and changes in upstream water policy will have greater effects as water levels change. Despite these problems, people continue to move to coastal areas at a high rate.

The timing surrounding adaptation activities is important. Many communities think climate change will only affect them on the many-century scale, but that they will still be living without feeling the effects of climate change in the next 10 years. While this may be true, adaptation strategies need to start being implemented, such as building of bridges, buffering roadways, etc. In the Outer Banks specifically, questions arise as to when to stop repairing existing roadways in favor of building causeways instead, and when to just give up on bridging infrastructure completely and use ferries. In some places opposition exists to doing anything about it these issues now, even though its clear changes will soon be necessary. The National Climate Assessment can play an important role in helping communities deal with such time horizons by projecting what might happen and when such changes might occur.

Road maintenance to the Outer Banks will have major implications for the lifestyle and work habits for residents, retirees, and telecommuters. Road maintenance will also have major implications for the local economic base, such as local stores, services, and other business, which will continue to develop under the assumption that there will be access to these businesses via roads long into the future. If local business owners were to know in advance that a road would be discontinued, they might choose to locate themselves in a more easily accessible locale. Therefore, the path chosen now has serious implications on economic development, which in turn feeds back into the demand for what is done and the choices made by policy makers.

Finally, there is the issue of compensation. Ethically the situation is straightforward: the rural poor have generally not contributed much to GHG concentrations, and do not have the resources to adapt, so a case can be made for compensation. However, it needs to be done in a way such that it does not remove the incentive to adapt. Incentives should compensate for damage and adaptation requirements. As much as possible, there should be clarity on the timing of when things are expected to happen, there should be an understanding of the interplay between planned and autonomous adaptation, and the possibility of compensation as part of public policy in low-density, high-vulnerability areas should be considered.

The third “case study” presentation focused on what agricultural communities in Iowa are doing to prepare for climate change. Like elsewhere, Iowa is experiencing changes in climate. Iowa is experiencing more frost-free days, the number of days below zero is going down significantly, slight increase in precipitation are occurring. However, summer changes are less pronounced: the number of hot days is actually not going up because there appears to be a “hole” in the US summer warming patterns surrounding Iowa. The reason for this hole remains unknown.

Excess precipitation presents a challenge to farmers. Even though the increase in precipitation appears slight on a yearlong scale because of averages in seasonal variability, a large increase actually does occur

in the spring during the planting season. One common adaptation strategy seen in Iowa is to install drainage tile under the soil to allow excess moisture to drain away. Currently, more than a million miles of drainage tile are in place throughout Iowa. However, while these tiles have surface benefits, they have led to water quality problems because the tiles allow a greater quantity of nitrogen from surface fertilization to run into the ground water. Another adaptation strategy that farmers are using is buying bigger and faster planting machines. As precipitation rises in spring, the window for planting becomes shorter and shorter; faster machines are needed to take advantage of what is currently a 5-day planting window.

Other factors causing problems for farmers include humidity and the frequency of extreme events. Humidity is increasing because of increased rainfall and dew points have been going up, which results in increased pathogens for crops, as well as increased mold in basements. The frequency of extreme events has also gone up dramatically in recent years. This is especially seen in flooding patterns: major floods have occurred in 1993, 2008, and again in 2010, even though each of these was equivalent to a 100 year flood event.

Farmers are demonstrating the capability to adapt to these changes. They are planting longer season hybrids to increase yields, they are buying larger machinery, planting at higher densities, installing more subsurface tile, spraying more frequently for pathogens, purchasing wider bean heads to allow for faster fall harvests, and, because of drier autumns on average, are delaying harvests in order to take advantage of these natural dry-down conditions. All of these things result in higher yields overall, suggesting the capability to adapt and benefit from changes seen to date.

Working with Rural Communities

Two presentations in the final afternoon demonstrated outreach efforts that were underway in rural communities. The first of these focused on Extension efforts in rural Arizona. In this presentation, Extension was defined as a function designed to complement existing agriculture programs, by working with stakeholders and natural and social scientists on program development and facilitate partnerships between Cooperative Extension and the Climate Assessment for the Southwest (a NOAA-RISA initiative). Across the country there is a growing network of climate extension agents and specialists in land and sea grant institutions, and overall there has been a dramatic increase in support of climate-related extension efforts.

Extension has a history of working on climate related issues, as for example during the Dustbowl of the 1930's. Extension also has cross-cutting expertise and the ability to work with diverse clientele. In Arizona, the Climate Extension Project was designed to understand how rural Arizonans understand, plan for, and respond to changes in weather and climate in their daily lives. The project was designed as a series of focus groups in eight counties that were created during a pre-interview with county Extension directors to scope out main questions that need to be addressed related to climate change and participants that needed to be included. Focus groups meetings were held over lunch and facilitated by academic Extension specialists. The project was co-facilitated by county managers who lived in the community and were familiar with what community members would be a valuable asset during the meetings.

When meetings began, Extension agents did not start by talking about climate change, but rather asked about how weather and climate affected the lives of those in the focus groups: participants were very willing to talk about this subject. They had no doubt that climate affected their lives, however it was apparent that questions existed about attribution, and legacy resource issues remain a fundamental problem. Overall, an enthusiasm for the assessment process was evident among the participants, and by taking part in it, both the community members and Extension agents felt like they were engaging in an important education opportunity for the community.

The second presentation was about the Coweeta Listening Project, a project of the Coweeta Long Term Ecological Research (LTER) Center in North Carolina. This area was chosen for a socioecological study because it was very immersed in rural tradition, has a great deal of biodiversity, is the “water tower” of the Southeast, and is also one of the fastest growing areas of the country.

The project was based upon the idea that there is a spiral mode of learning that begins with hearing about the experiences of the participants. After these experiences are gathered, one can insert a search for patterns, which is expanded upon by adding in new academic research and information. Altogether, the learning from this sort of exercise is used to help participants practice new skills, strategize, and plan for action, all of which leads to application of new ideas. Using these ideas, the Coweeta Listening Project was built around the idea of empowering the local community, and the notion that active and deep listening builds trust, with the result that those being interviewed act less defensively and open up to exploring new ideas, feelings, and solutions. By acknowledging that their opinions and knowledge matters, people become empowered to aid in finding effective solutions to difficult problems such as climate change.

The Project commenced with a meeting with the editor of a local paper, who agreed to let Project directors write a regular column in the local paper. This column contained full contact details for the Coweeta Project directors, and encouraged community response. They also designed posters describing their efforts, which were put up throughout the community, as well as creating a website that provided additional information and public access. Through all these means, the Coweeta Listening Project is collecting input from the community about what climate change means to the community, what impacts individuals are seeing, and what concerns they might have.

V. Knowledge Gaps and Future Needs

The final session of the workshop was a facilitated discussion on the topic of knowledge gaps and future needs. Notable points from the discussion are captured below:

Participants were asked about data gaps, and the discussion started when someone noted that regarding regional forecasts and projections, people need to see more concrete outputs. Enormous volumes of data are available from the National Weather Service, airports, and Mesonets, that state climatologists, academics, and agency professionals might use to provide the public with more concrete climate projections. Seasonal forecasts are also important, with the expectations that 10-year time scales are required, and providing a thoughtful look at possible extremes within these projections would also be useful. While terabytes of data are available, in many cases the data are either stored poorly, are not combined in the way that people need, or are incomprehensible to non-experts. This information has many applications, but thought needs to go into how to better prepare, downscale, and use it. It was also noted that more biological data with overlapping human and social impacts would be useful. Finally, common units of analysis would be useful for many studies, and studying systems from a watershed scale might be such a useful approach.

Participants were next asked about the ongoing assessment process. For the National Climate Assessment and the ongoing national assessment process, more guidance is needed on how to effectively perform assessments. Many rural communities may be asked to participate in assessments, but templates and models of the kind of questions to be asked locally would be helpful. It would also be useful to identify three or four research areas where long-term partnerships can be created between federal government and rural communities. Guarding against unfunded federal mandates will be important, as will avoiding language that leads communities to feel that they have to perform an assessment. Also, it is important to keep in mind that assessments work when leadership wants to – and does – use it, but if there is no political will, it is a waste of time. Finally, it is also important to remember that stakeholders have been engaged many times previously and lots of data already exist, but this information is not always well used. To address this issue, it will be important to streamline and synch up available data sets. An inventory of what is going on within the realm of climate adaptation at the local level would also be useful.

Societal, behavioral, and economic research in relation to climate change and rural communities was the next topic of conversation. Participants acknowledged that this was an area where not enough research has been done. Lots of research has been done on how to prepare for what is changing, but more targeted literature reviews are needed of this research. This sort of research also needs to be designed to understand the priorities and approaches for sustainability by individuals and communities. Finally, the issue of “in-reach” was brought up: how can the trainer be trained to ensure that people are literate on climate change, and how do is it possible to ensure that different interests in society are equally prepared, and overlap as necessary? One useful tool would be to have a clearinghouse of practices of who is doing what, where they are doing it, and why they are doing it.

On the topic of communication, education, and Extension, participants noted that vulnerable populations need greater and more immediate attention. Some organizations are already out in front when it comes to working with these groups, including the United States Conference of Mayors, the University Presidents’ Climate Commitment, and the National Association of Regional Councils. Participants pointed out that

listening is key, and it is important to not “message to” people. Some research needs to be done on presence and absence of an issue, to see how people both deal with and without it, which may lead to a more comprehensive understanding of the issue. Finally, it might be useful to develop cross-community and cross-national networks of Extension agents to make sure all are on the same page regarding climate issues, and each can share their knowledge across communities; regional rural development centers fulfill this role to some degree. One other way of doing this might be having required in-service training or continuing education for Extension agents that could be coordinated by these development centers.

VI. Conclusions

While the large of participants from diverse backgrounds ensured that the workshop resulted in a wide-range of opinions and information, many themes emerged time and again throughout the talks, breakout sessions, and facilitated discussions. Some of the most prevalent reoccurring themes included:

- The economic foundation of rural areas will be measurably impacted by climate change, and while autonomous capacity to respond is very strong, governmental ability to anticipate, prevent, and respond is weak.
- Rural communities are all very different, and there is no one clear definition of what a rural community is. The results of this workshop have been very aggregate, but we cannot think about rural communities on such a scale. Different physical factors, different resources, different demographics, and different social values are overlapping and at work in rural communities, such that there will never be a one-size fits all approach to tackling climate change at a rural scale. The key to success will be in listening to individual communities, understanding their unique needs, and finding adaptive ways to work within the confines present in each community.
- Timing of response is critical, as is improving the efficiency of the adaptation response, and improving communication on the timing of responses can allay some fears about climate change.
- Flexibility of governance is needed to accommodate the differing situations of each community. Rural communities often feel trapped by existing rules and regulations. In order to facilitate success and support substantive changes in communities, larger scale governance needs to leave room for communities to act in ways most suitable to them.
- System wide adaptation tends not to support the building of capacity at the community and collective level.
- There is a value and need for Extension. Extension is a trusted source for many communities, including minority communities, which may not be willing to work with other players. Extension also has the benefit of being coordinated by networks, which can work to ensure that all specialists are on the same page when it comes to climate change issues.
- It is important to convey the risks of climate change clearly to rural communities. Understanding the context for decision making, the value systems in rural communities, where individuals get information, and methods for gathering information will help improve how communities approach and respond to climate change. Framing climate change in the context of risk management, resource and community sustainability, and resilience to climate variability can be effective communication strategies.
- Low income populations have fewer resources and a lower ability to deal with change.
- Governments cannot simply hand down information and decisions to local communities. It is essential to develop channels for dialog. This can be done through Extension, or with other players and networks that are ready to listen, or by building upon existing community knowledge.

It is important to remember that rural communities are not “backward,” they do, however, often have unique needs, cultures, value systems, and ways of doing things.

- Communication and terminology can prove problematic; for example, there are varying meanings of the word mitigation (e.g., emergency management use to minimize hazard, versus IPCC use related to reducing GHG emissions). Authorities need to coordinate and come up with concise and consistent terms that are used across a wide range of groups, to avoid confusion and enhance communication.
- Greater value needs to be put on ecosystem services. These services are among the nation’s greatest assets, which are located in rural communities. Preserving ecosystem services not only sustain rural communities, they will benefit those who come to rural communities for second homes, tourism, and other ecologically-driven reasons, as well as provide urban residents with vital resources that meet essential needs, such as clean drinking water.
- Rural communities are resilient to climate change because of their face-to-face relationships which facilitate cooperation, response, and mutual support. Rural communities are vulnerable because they have low populations, weak institutional capacity, and high transportation costs, which limit their capacity to plan and respond.
- Greater emphasis on understanding interactions between the physical, biological, and social systems will be increasingly important under changing climate. This reality may be more the case in rural areas of the United States, where the linkages are pronounced and if linkages break, the effects will have a broad impact on communities both rural and urban across the United States. To ensure that rural communities are adequately prepared to cope with the effects of changing climate, expertise and efforts relied upon to promote resilience and sustainability must necessarily be interdisciplinary in nature.

Appendix A: Agenda

Main Meeting Objectives:

The purpose of this meeting is to generate a technical report that will be submitted to the National Climate Assessment as part of the 2013 Assessment process, and which will be used to guide the writing of the chapter of the Assessment dedicated to Rural Communities. In order to do this, workshop attendees are asked to share their expert opinions on how to anticipate and characterize changes in rural America due to climate change, how to provide both context and detail of the challenges to rural wellbeing associated with global climate change, and how to set the stage for wise action that preserves the values and resources which communities across the country cherish.

February 13

General Sessions held in Cypress Room

(8:30-9:00) Coffee and Breakfast

(9:00-10:00) Welcome and Introductions

Presentation 1: Brief welcome, participant introductions, and background on technical report (*David Hales, President, College of the Atlantic and Bill Hohenstein, Director of the Climate Change Program Office, USDA*)

Presentation 2: Introduction to the National Climate Assessment (*Ralph Cantral, National Climate Assessment*)

(10:00-12:00) Session 1: Overview of Rural Communities, Climate Change, and How Climate Change may affect Rural Communities

Plenary 1: Rural Community Resilience and Climate Change (*David McGranahan, USDA Economic Research Service*)

Plenary 2: Climate Trends and Outlooks for the United States (*Laura Stevens, NOAA*)

Plenary 3: Climate Change & Rural Communities: Socio-economic Impacts (*Evan Mercer, USDA Forest Service*)

30 minute facilitated discussion on plenary subjects

(12:00-13:00) Lunch on your own (see reference sheet for restaurant suggestions)

(13:00-15:10) Session 2: Socioeconomic Factors of Rural Communities and Climate Change

Presentation 1: An examination of factors influencing climate-related health outcomes in rural versus urban communities (*Julia Gohlke, University of Alabama*)

Presentation 2: Climate change and transportation in Maryland (*Greg Slater, Maryland Department of Transportation*)

Presentation 3: Climate Change Governance and Finance Issues for Rural Communities - An EPA Perspective (*Ken Mitchell, EPA*)

Presentation 4: Resource utilization driven economy and employment (*Wolfram Schlenker, Columbia University*)

Presentation 5: Implications of Climate Change for Recreation and Tourism in Rural Areas (*Sarah Nicholls, Michigan State University*)

30 minute facilitated Discussion

(15:10-15:30) Coffee Break

(15:30-18:00) Session 3: Break Out Groups

Breakout Group 1: Wellbeing and health (*Beauregard Room*)

Breakout Group 2: Infrastructure, transportation, energy (*Colleton Room*)

Breakout Group 3: Governance and finance (*Edmunds Room*)

Breakout Group 4: Resource utilization driven economic factors and employment (*Drayton Room*)

Breakout Group 5: Amenity driven economic factors and employment (*Ashley Cooper Room*)

(18:00 – 18:15) End of day summary and updates (*Bill Hohenstein*)

Reception in Palmetto Garden Room beginning at 18:15

February 14

Sessions all day held in Riviera Ballroom

(8:30-9:00) Coffee and Breakfast

(9:00-9:15) Brief review of past day and overview of upcoming day (*David Hales*)

(9:15 – 10:15) Report out from breakout groups

(10:15- 10:30) Coffee Break

(10:30 – 12:30) Session 4: Case Studies Discussion

Case Study 1: Climate Change in the Southern Rockies: case study from the western slope of southwest Colorado (*Marcie Demmy Bidwell, Mountain Studies Institute*)

Case Study 2: Adaptation in Low - Population Density Coastal Areas: Key Issues on North Carolina's Outer Banks (*Andy Keeler, East Carolina University*)

Case Study 3: Adaptation to Climate Change: Challenges to Farmers and Small Towns in the US Midwest (*Gene Takle, Iowa State University*)

30 minute facilitated discussion

(12:30-13:30) Lunch on your own

(13:30-14:30) Session 5: Working with rural communities: opportunities, partnerships, and communication

Presentation 1: Climate Science Extension in Arizona: Lessons from the Road (*Michael Crimmins, University of Arizona*)

Presentation 2: Popular Ethnography and Climate Vulnerabilities: Lessons from the Coweeta Listening Project (*Nik Heynen, University of Georgia*)

(14:30 – 15:30) Session 6: Knowledge Gaps and Future Needs

Roundtable discussion facilitated by Bill Hohenstein and David Hales

(15:30-15:45) Coffee break

(15:45 - 17:00) Conclusions from author teams and leads, adjourn

Roundtable discussion facilitated by David Hales and Bill Hohenstein

Appendix B: Breakout Questions

Rural communities have a set of characteristics which makes them uniquely vulnerable as well as potentially well positioned to find opportunity in changing climate conditions. Rural communities are often economically-limited, have reduced access to health care and transportation, have professions which are dependent upon their natural resource base and susceptible to changes in climate, and may pay a premium for energy use. Perceptions of risk and uncertainty vary, with many predisposed to be skeptical of environmental movements including claims of climate change, its causality, and the need to take adaptive and/or mitigative actions. As you carry on discussions in your breakout groups, keep these common factors in mind and try to include them in your estimation of how climate change is affecting and will continue to affect rural communities.

1) Wellbeing and health

- What health concerns are unique to rural communities in general, and how are climate changes going to be exacerbating these concerns?
- How will the sexes be differently and perhaps disproportionately affected?
- How will changes in temperature extremes be expected to have deleterious or positive health effects on rural communities?
- Do fewer people in RC have access to health insurance and quality healthcare and how will this affect them?
- What sorts of communication efforts are needed in order to inform rural populations about health issues?
- What are the best sorts of policies that local governments can institute in order to protect vulnerable populations? Would these treat symptoms or causes?

2) Infrastructure, transportation, energy

- What transportation issues are unique to rural communities and how will climate change affect these transportation options?
- What sort of role will increased public transportation play or need to play and what sorts of non-traditional alternatives to transportation problems might be needed?
- How can energy generation help build rural communities? What options are already under development and what needs to be further developed?
- How might renewables be accepted within rural communities? What perceived value/benefit might rural community members see themselves gain from using renewable energy?
- How can utilities begin to adapt? What are some examples already in place?
- What are some of the positive aspects of climate change and energy for rural communities?

3) Governance and finance

- What are some of the major challenges or changes expected by local governments as a result of climate changes? How will this affect rural communities' financial structure (taxes, expenses, etc)?
- What sorts of changes in tax and other financial policies help prepare local communities for climate change? Beyond taxes and financial policies, what other tools might assist with enhancing community resilience to effects of climate change?
- What role can NGO and/or federal government actors play in helping governments adapt and prepare? What opportunities exist for NGO/partners to communicate with local/regional governments about the importance of adaptation plans, and to collaborate with local governments to develop these plans?
- How is information on climate change and adaptation and mitigation strategies delivered to rural residents, e.g., the overall picture, projections of future temperature/precipitation from models? What methods, networks, and media do local governments use to communicate with their constituents that might communicate information regarding climate change and potential adaptation strategies?
- What do rural community members perceive as the costs for dealing with climate change and adaptation needs because of, e.g., increases in crop cover (to reduce carbon emissions), reduced use of nitrogen and methane capture? How are these best addressed in adaptation/mitigation governance?
- How can adaptation efforts involve community members, capture local knowledge, and incorporate community input into adaptation governance strategies? How can information and lessons learned be shared with other communities who might face similar issues?

4) Resource utilization driven economic factors and employment

- What are some of the major changes expected in the agriculture sector as a result of climate change? In the fisheries sector? In the forestry sector?
- What sorts of business incentives can the government provide in order to help producers change and adapt?
- What sorts of educational and outreach programs will be needed to train producers about alternatives?
- What kinds of social networks are already in place to help these industries adapt, and how can the government further strengthen those networks? How will extension play a role?
- How will rural communities deal with un- or under-employment, and can new educational opportunities ameliorate related problems?
- How will changes in these industries affect the demographic of rural communities, and do we expect to see gender/age differences in effects?

5) Amenity driven economic factors and employment

- What are some of the major changes expected in the tourism sector as a result of climate change? In hunting/fishing sector?

- What sorts of business incentives can the government provide in order to help producers change and adapt?
- What sorts of educational and outreach programs will be needed to train producers about alternatives?
- What kinds of social networks are already in place to help these industries adapt, and how can the government further strengthen those networks? How will extension play a role?
- How will rural communities deal with un- or under-employment, and can new educational opportunities ameliorate related problems?
- How will changes in these industries affect the demographic of rural communities, and do we expect to see gender/age differences in effects?

Appendix C: Participants

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